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14. ABSTRACT

Radar and sonar systems are important military components of NATO operations. Their ability to function during all-day, relative immunity to weather, capability of localizing targets in range, long range operation, detection and tracking of mobile targets, and classification of objects, make them the sensors of choice in many situations. New emerging concepts use multiple radar/sonar systems in a netted environment. Under this new paradigm, each radar/sonar can receive and process its own signal and/or the signal of other local sources. The application of bi-/multistatic can enhance the information quality gained by a single radar/sonar system. Likewise the fusion of data provided by networks of netted active or passive radar/sonar systems increases the overall performance. As battlefield scenarios become more complex, with ever growing numbers of sensors and weapon systems, the challenge will be to maximize the collection of information and to use that information effectively for enhancing radar performance.

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Multistatic Surveillance and Reconnaissance: Sensor, Signals and Data Fusion

(Surveillance et Reconnaissance Multistatiques : Fusion des capteurs, des signaux et des données)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Sensors and Electronics Technology Panel (SET) presented on 06-07 April 2009 in La Spezia, Italy; 23-24 April 2009 in Wachtberg, Germany and on 27-28 April 2009 in London, United Kingdom.

Published April 2009

The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS System Analysis and Studies Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Multistatic Surveillance and Reconnaissance: Sensor, Signals and Data Fusion

(RTO-EN-SET-133)

Executive Summary

Radar and sonar systems are important military components of NATO operations. Their ability to function during all-day, relative immunity to weather, capability of localizing targets in range, long range operation, detection and tracking of mobile targets, and classification of objects, make them the sensors of choice in many situations.

New emerging concepts use multiple radar/sonar systems in a netted environment. Under this new paradigm, each radar/sonar can receive and process its own signal and/or the signal of other local sources. The application of bi-/multistatic can enhance the information quality gained by a single radar/sonar system. Likewise the fusion of data provided by networks of netted active or passive radar/sonar systems increases the overall performance. As battlefield scenarios become more complex, with ever growing numbers of sensors and weapon systems, the challenge will be to maximize the collection of information and to use that information effectively for enhancing radar performance. This Lecture Series brought together the leading research developments with the NATO community.

The objective of this Lecture Series was to present the state-of-the-art radar/sonar sensors in multistatic configurations and associated radar/sonar signal and data processing and fusion techniques, and thereby increase awareness of their value to the NATO scientific and engineering communities. The lecture series reviewed current developments in this area, presented examples of bi-/multistatic radar/sonar networks and their data fusion and processing to improve the overall performance of the system.

This Lecture Series covered: Fundamentals of signal processing for phased array radar, covert radar waveform design and processing, signal and data processing, bistatic and multistatic radar/sonar, active and passive radar, netted radar, characteristics of potential illumination sources, passive coherent localization radar (PCL). This Lecture Series reviewed the current developments in the technology area of digital antenna systems, and distributed and layered sensing. In addition, the series covered target location, advanced target detection and multistatic tracking techniques, fusion and networking with sensors systems, and passive radar denial.

Surveillance et Reconnaissance Multistatiques : Fusion des capteurs, des signaux et des données

(RTO-EN-SET-133)

Synthèse

Les systèmes radar et sonar sont des composants importants des opérations OTAN. Leur capacité à fonctionner en continu, leur résistance aux conditions météorologiques, leur capacité à localiser les cibles à portée directe et à longue distance, à détecter et à poursuivre des cibles mobiles et à classifier des objets, font d'eux les capteurs de choix dans de nombreuses situations.

De nouveaux concepts utilisent plusieurs systèmes radars/sonars en réseaux. Selon ce paradigme, chaque radar/sonar peut recevoir et traiter son propre signal et/ou le signal d'autres sources locales. L'application des systèmes bi-/multistatiques peut améliorer la qualité de l'information obtenue par un système radar/sonar unique. De même, la fusion des données fournies par les réseaux ou les systèmes maillés radar/sonar actifs ou passifs accroît l'ensemble des performances. Comme les scénarios tactiques deviennent de plus en plus complexes, avec un nombre grandissant de capteurs et de systèmes d'armes, le défi sera de récupérer le maximum d'informations et de les utiliser efficacement pour améliorer les performances radar. Cette série de conférences rassemble les principaux développements de la recherche au profit de la communauté OTAN.

L'objectif de cette série de conférences était de présenter l'état de l'art en matière de capteurs radar/sonar dans des configurations multistatiques et les signaux radar/sonar associés ainsi que le traitement des données et les techniques de fusion, afin de renforcer la prise de conscience de leur utilité par la communauté scientifique et technique de l'OTAN. La série de conférences a passé en revue les développements actuels dans ce domaine, et a présenté des exemples de réseaux radar/sonar bi-/multistatiques, leur fusion et leur traitement de données, pour améliorer la performance globale du système.

Cette série de conférence a traité : Des principes fondamentaux de traitement des signaux pour les radars à balayage électronique, la conception et le traitement de la forme des ondes de radars discrets, le traitement des signaux et des données, les radars/sonars bi-statiques et multistatiques, les radars actifs et passifs, les radars en réseaux, les caractéristiques des sources d'illumination potentielles, les radars passifs de localisation cohérente (PCL). Cette série de conférences a passé en revue les développements actuels dans le domaine de la technologie des systèmes d'antennes numériques et de la détection répartie et en couches. De plus, la série de conférence a traité de l'emplacement des cibles, des techniques évoluées de détection des cibles et de la poursuite multistatique, de la fusion, du maillage avec les capteurs et de l'interdiction par radars passifs.

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